REMARKS

Upon entry of the Amendment, Claims 22-32 will be pending in the application. Claims 1-21 were previously canceled.

Claims 22-23 are amended to recite "the phosphorous compositional ratio (X) of the $GaN_{1-X}P_X$ lower clad layer is set to obtain the lattice matching with the BP-based buffer layer". Support can be found, for example, starting at page 14, line 1 to page 16, line 1 of the specification as originally filed. Claim 22 is further amended to replace "$GaN_{1-X}P_X$ light-emitting layer" with "$Ga_YIn_{1-Y}N$ ($0.1 \leq Y \leq 1$) light-emitting layer" to correct an inadvertent error. Support can be found, for example, at page 12, lines 25-32 of the specification as originally filed. No new matter is added.

Claims 24-27 are amended to depend on Claim 22 or 23.

New independent Claims 28-29 and dependent Claims 30-32 are added. Support can be found, for example, starting at page 15, line 31 to page 16, line 9, and at page 4, lines 10-18 of the specification as originally filed. No new matter is added.

Entry of the Amendment along with reconsideration and review of the claims are respectfully requested.

Format Matters

Applicant appreciates that the Examiner has acknowledged Applicant's claim for foreign priority and the receipt of the priority documents in parent Application No. 09/885,943.

Applicant also appreciates that the Examiner has reviewed and considered the references cited in the Information Disclosure Statement filed January 9, 2004.

Statement of Substance of Examiner's Interview

The undersigned called the Examiner on December 29, 2004, to propose new claim amendments and to request an Interview prior to the filing of this response. Applicant's representative faxed to the Examiner a set of proposed claim amendments, substantially as presently filed, for the Examiner's review prior to a telephonic interview scheduled for January 3, 2005. During the telephonic Examiner's Interview, the Examiner indicated that he preferred to review Applicant's Amendment once filed in order to conduct a thorough examination, and the interview was ended.

Claim Rejections - 35 U.S.C. § 112

A. In response to the rejection, under 35 U.S.C. §112, first paragraph, Claim 22 has been amended to replace "$GaN_{1-X}P_X$ light-emitting layer" with "$Ga_YIn_{1-Y}N$ ($0.1 \leq Y \leq 1$) light-emitting layer", finding full written description support in the specification as originally filed.

Accordingly, Applicant respectfully requests reconsideration and withdrawal of the rejection under 35 U.S.C. § 112, first paragraph. As Claim 22 is not otherwise rejected, Applicant respectfully requests allowance of at least this claim.

B. In response to the rejection, under 35 U.S.C. §112, second paragraph, Claims 24-27 have been amended to depend from Claim 22 or 23.

Accordingly, Applicant respectfully requests reconsideration and withdrawal of the rejection under 35 U.S.C. § 112, second paragraph.

Claim Rejection - 35 U.S.C. § 103(a)

Claim 23 was rejected under 35 U.S.C. §103(a) as being unpatentable over Terashima et al (U.S. Patent No. 6,069,021) in view of Ishida et al (U.S. Patent No. 6,339,014).

The Examiner cited Terashima et al as teaching a group-III nitride semiconductor light-emitting device comprising a double hetero-junction light-emitting part structure containing a $GaN_{1-x}As_x$ lower clad layer ($0< x < 1$), a $Ga_\gamma In_{1-\gamma}N$ ($0\leq \gamma \leq 1$) light-emitting layer and an $Al_zGa_{1-z}N$ ($0\leq z \leq 1$) upper clad layer having a conduction type (p-type) opposite that of the lower n-type clad layer.

The Examiner recognized that Terashima does not teach a lower clad layer containing phosphorus. However, the Examiner asserted that it would have been obvious to use phosphorous (P) instead of arsenic (As) for doping in view of Ishida et al, which the Examiner cites as teaching that P and As are equivalent for growing n-type GaN layers.

The Examiner concluded that given the use of P-doping in a prior step in Terashima et al, namely, in the formation of the buffer layer 102 (see Terashima, col. 13, lines 59-65), it would have been obvious to use the same dopant, thus obviating the need for additional complexity in the manufacturing process, while the lattice matching achieved by selecting arsenic as taught by Terashima et al could have been equally achieved through doping with phosphorous.

Applicant responds as follows.

Claim 23 has been amended to recite that "the phosphorous compositional ratio (X) of the $GaN_{1-X}P_X$ lower clad layer is set to obtain the lattice matching with the BP-based buffer layer", based on support, for example, starting at page 14, line 1 to page 16, line 1 of the specification as

originally filed. Furthermore, each of Examples 1-5 describes a lattice matching relationship between the lower clad layer and the buffer layer (see for example the bridging paragraph of pages 17-18). When a lattice matching relationship is achieved between the gallium nitride phosphide lower clad layer and the BP-based buffer layer, this contributes to the formation of a single hetero- or a double hetero-junction structure light-emitting part comprising a crystal layer having excellent crystallinity, and therefore light emission with higher intensity can be attained.

On the other hand, neither Terashima et al nor Ishida et al discloses or teaches setting the phosphorous compositional ratio (X) of the $GaN_{1-X}P_X$ lower clad layer to obtain lattice matching with the BP-based buffer layer. Thus, Claim 23 is patentable for at least this reason.

Moreover, there is no motivation to one of ordinary skill to combine Terashima et al and Ishida et al, or rather to apply Ishida et al to Terashima et al which is said to teach that P and As are equivalent for growing n-GaN layers to Terashima et al for the following reasons.

Terashima et al describes a light-emitting device, including light-emitting layer 105 made of GaInN provided via lower cladding layer 104 made of n-type GaN doped with Si on a buffer layer including crystalline layer 103 made of BP and amorphous (polycrystalline) layer also made of BP. However, a significant difference between Terashima et al and the present invention is that in the present invention the lower clad layer must contain P, whereas Terashima's lower cladding layer 104 does not contain P. Furthermore, there is nothing in Terashima et al which teaches or suggests adding P to lower cladding layer 104. Terashima et al is utterly silent with respect to adding P to lower cladding layer 104.

Although Ishida et al describes in a second embodiment that a GaN layer (8) was grown by supplying AsH_3 gas or PH_3 gas in addition to the source gases or by supplying nothing but the source gases (see col. 6, lines 62-65), such teaching alone does not render the claims obvious. Both P and As are n-type dopants, and the amount of their addition to the GaN layer is only usually about 0.1 at%. However, the claims require more than just a n-doped GaN layer, but specifically call for a $GaN_{1-x}P_X$ lower clad layer having a phosphorus compositional ratio set to obtain lattice matching with the BP-based buffer layer. One of ordinary skill in the art would recognize that a GaNP or GaNAs single crystal layer suitable as a lower clad layer is not necessarily formed by merely adding P or As as a dopant to GaN. That is, simple substitution of buffer dopants in a GaN layer, as taught by Ishida et al, does not lead to a lattice-matched lower clad layer. For the same reasons, Applicant respectfully submits that there is no motivation to apply Ishida et al. to Terashima et al in the manner suggested by the Examiner.

Moreover, none of Terashima et al and Ishida et al recognizes the merit of Applicants invention of adding P to GaN single crystal layer in contact with the upper buffer layer. As described at page 20, lines 28-32 of the present specification, the degree of lattice mismatch between the lower clad layer comprising GaNP single crystal and the light-emitting layer comprising GaInN can become 0.3% at most. See [0078], [0100], [0126]. As a result, a light-emitting layer having reduced crystal defects attributable to the lattice mismatch can be formed.

Accordingly, Applicant respectfully requests reconsideration and withdrawal of the obviousness rejection against Claim 23.

Conclusion

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

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